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Phase I

FISHERIES OVERVIEW

Ecological Component

Oldman River Dam

Environmental Mitigation/Opportunities Plan

prepared for

Alberta Environment

Planning Division

Edmonton, Alberta

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by

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EXECUTIVE SUMMARY

The Alberta Government intends to build a dam on the Oldman River north of the Town of Pincher Creek, Alberta. The purpose of the dam, known as the Oldman River Dam, is to create a reservoir that will provide a dependable flow of water down stream for multiple uses.

The Planning Division of Alberta Environment is preparing an Environmental Mitigation/Opportunities Plan for the dam project.

This report provides an overview of the fish populations, habitat and sport fishery in the area affected by the dam, reviews probable impacts on the fishery resources and potential mitigation and identifies data gaps and areas for further study for inclusion in Phase 1 of the Mitigation/Opportunities Plan.

The effects of the Oldman River Dam may be manifested as far downstream as the mouth of the Oldman River, however the fisheries overview study area was restricted to a 125 km section of the Oldman River upstream from near Fort MacLeod, a 26 km reach of the lower Castle River upstream from its mouth and a 12 km section of the Crowsnest River between its mouth and Lundbreck Falls.

The fish populations in the study area consist of coldwater and coolwater species. The coldwater species, the trouts and mountain whitefish, are much sought after by anglers, but are relatively intolerant of environmental changes. Mountain whitefish are widely distributed throughout the study area and are the most abundant sport fish present. They complete their entire life cycle within the study area, migrating between spawning, feeding, rearing and overwintering habitats. Standing crops of mountain whitefish in the study area are about 200 to 300 kg/hectare. Rainbow trout are found in the study area downstream to below the Lethbridge North Irrigation District (L.N.I.D.) weir near Brocket. Life cycle phases such as feeding, rearing and overwintering are carried out within the study area streams, however spawning likely takes place upstream of the study area. Bull trout occur occasionally in the study area downstream to the L.N.I.D. weir. Cutthroat trout are found rarely downstream as far as the weir. Brown trout are found in the study area only in the lower Crowsnest River (below Lundbreck Falls) and are apparently completing their life cycle in this reach of the river. Lake whitefish are a coolwater species that can tolerate some coldwater conditions. They are primarily a lacustrine species found in many irrigation reservoirs in southern Alberta and occasionally occupy the Oldman River as far upstream as the L.N.I.D. weir. Coolwater sport species found in the Oldman River Dam study area include northern pike, walleye and goldeye. The latter two occur rarely at the downstream study area boundary

whereas pike have been noted above the L.N.I.D. weir and may be spawning in the Oldman River main stem above the weir. There are a number of facultative (able to tolerate both coldwater and coolwater conditions) non-sport species in the study area. White, longnose and mountain suckers and burbot are widely distributed throughout the study area. The sucker species complete their entire life cycles within the study area streams.

The sections of the 3 rivers included in the study area are all rated as class 1 for sport fish capability. Those portions above Brocket are considered coldwater habitat while the section of the Oldman River main stem below Brocket is transitional between coldwater and coolwater habitat. The coldwater habitat is of particularly high quality. Spawning habitat for mountain whitefish is widely distributed as are feeding areas. Overwintering habitat is abundant above the L.N.I.D. weir and in the lower Castle River, but is not common in the lower Crowsnest River and may be limited in the Oldman River main stem below the L.N.I.D. weir. Rearing habitat for young-of-the-year mountain whitefish may be somewhat limited below the weir however rearing areas for juvenile mountain whitefish are abundant throughout the study area. Feeding areas and rearing and overwintering habitat for rainbow trout is fairly abundant, however spawning habitat appears to be sparse. There is apparently some suitable spawning, rearing and overwintering habitat for brown trout in the lower

Crowsnest River as they are successfully completing their life cycle there. Spawning, feeding and overwintering areas for the non-game species are abundant, however rearing areas may be lacking in the study area. Northen pike spawning and rearing habitat and probably overwintering habitat is sparse, as would be expected at the upper end of their distribution limit in the Oldman River.

The Oldman River Dam study area lies within one of the most intensively sport fished watershed units in Alberta. Anglers are attracted in high numbers by the prospect of catching a "wild" trout (naturally reproduced) in aesthetically attractive surroundings. The section of the Oldman River downstream of the Oldman River Dam site is utilized predominantly by local anglers, however the Oldman River above the dam site, the Castle River and the Crowsnest River have provincial importance as sport fisheries. The Crowsnest River sport fishery has attracted international attention and has been described as Alberta's best rainbow trout stream.

Construction of a dam on the Oldman River could result in increases in sedimentation and water pollution, block fish movements, cause mortalities of fish due to the use of explosives and dewater the river channel below the construction site, all of which are detrimental to aquatic resources. Subsequent to the creation of a large reservoir at the Oldman River Dam site, changes are likely to occur in the fish

populations in streams above the reservoir. Non-sport (coarse) fish species will likely predominate over the more desireable trout and whitefish, primarily on a seasonal basis and particularly in that section of the Crowsnest River isolated between Lundbreck Falls and the reservoir. The reservoir created by the Oldman River Dam will flood 17.5 km of the Oldman River, 9.5 km of the lower Castle River and 6.5 km of the lower Crowsnest River. Inundation of this high quality, coldwater, riverine habitat will displace the mountain whitefish and trout species that currently utilize these streams for spawning, rearing, feeding and/or overwintering. The reservoir fish population will become dominated by non-sport species, principally white suckers. Mountain whitefish will be the only sport fish species occuring in any appreciable numbers in the reservoir. Initially the reservoir will be fairly productive due to the influx of nutrients from newly flooded terrestrial areas, however this phenomenon will last only 2 or 3 years. Reservoir productivity will decline to very low levels and will be capable of producing significantly fewer sport fish than the existing riverine habitat. Cold water temperatures and high water exchange rates are the main factors resulting in low reservoir productivity. The reservoir will offer poor quality fish habitat, depending on drawdown regimes, and will be poorly suited to angling. Fluctuating water levels will preclude the establishment of stable shallow water habitats suitable for fish spawning, feeding and rearing. Shoreline erosion occurring due to fluctuating water

levels will result in increased sediment deposition which will cover existing productive substrates. Strong prevailing winds will make boating very hazardous on the reservoir, implying that fishing may be restricted to shore. The probable drawdown regime for the reservoir suggests that ice conditions may be dangerous in winter, limiting ice fishing opportunities.

One of the most significant impacts of the Oldman River Dam will occur downstream of the dam. This impact can be either positive or negative. Normally, flows downstream of main stem irrigation reservoirs are dramatically reduced and have significant negative impacts on fish. This circumstance reduces available habitat, reduces the quality of remaining habitat and at worst, strands fish in isolated areas where they are susceptible to mortality. Diversion of natural flows into the L.N.I.D. system at the weir on the Oldman River frequently results in extremely low flows below the weir, to the significant detriment of fish and other aquatic life. It has been suggested that based on the initial design capacity and the stated purpose of the Oldman River Dam the potential exists to pass augmented flows to and beyond the L.N.I.D. weir to the benefit of fisheries resources downstream. The aquatic community below the Oldman River Dam is likely to be altered by the low temperature and higher nutrient levels of the water released through the low level delivery tunnel designed for the dam. Early in reservoir life, this water may be of such low quality as to cause downstream fish kills. Over the longer

term lower water temperatures may alter use by coolwater fish species; conversely lower water temperatures may be advantageous to coldwater fishes now residing in the river downstream of the dam site. Increases in nutrient levels downstream of the dam site, occurring because the deeper waters of the reservoir act as a nutrient sink, will increase productivity downstream. The Oldman River Dam will act as a barrier to upstream fish movements. Fish tend to accumulate below dams, particularly during upstream migrations, and if seeking spawning areas spawning failures may occur due to their inability to pass the dam. Concentrations of fish below dams are more susceptible to injury, harrassment and predation. The initial design of the spillway and delivery tunnel for the Oldman River Dam suggests that fish could become trapped in a section of channel isolated between the spillway outlet and the delivery tunnel outlet. If the Oldman River Dam can be operated to achieve its stated purpose, that of supplying adequate flows for downstream uses, one of which is assumed to be the maintenance of fisheries resources, then the overall impact on the fisheries resources downstream of the dam may be positive.

The impact of dam construction can be reduced or eliminated by incorporating guidelines for erosion control, sewage and refuse disposal, explosives use and fuel and chemical storage into a construction procedures plan. The options for reducing upstream effects are somewhat limited. Non-sport fish control

programs such as poisoning or construction of access barriers are both cost prohibitive and will adversely affect desirable species. Trapping and removal of seasonal concentrations of coarse fish species, while perhaps presenting some logistical difficulties, may be justifiable if the problem becomes excessive. The impact of the reservoir itself appears to be best mitigated by compensating for the loss of the existing high quality stream fishery, rather than attempting to create a fishery of similar quality within the reservoir. Some short term compensation can be effected by stocking fish, probably rainbow trout, to take advantage of the high productivity in the first 2 or 3 years of reservoir life. This would be a fairly short term fishery. The stocking of other fish species to establish self-reproducing populations would meet with limited success because of the poor quality habitat available in the reservoir. Improvement of reservoir habitat quality by creating suitable habitat areas in the reservoir has limited applicability. It is assumed that drawdown and operating regime scenarios for the Oldman River Dam will be forthcoming as part of the project planning process; when this information becomes available reservoir habitat enhancement possibilities can be further evaluated. Habitat enhancement in river reaches above the reservoir could increase recruitment of trout and mountain whitefish to the reservoir and improve the stream fisheries themselves, thereby in part compensating for the inundation and subsequent loss of trout and whitefish production. The river reaches within the study area with potential

for this type of mitigation and should be examined in detail in the near future to determine the feasibility of and methods for enhancing spawning, rearing and resting habitat for brown trout, rainbow trout and mountain whitefish. The potential for positive impacts downstream of the dam due to flow augmentation suggests that further study is required to determine the specific flow needs for downstream fisheries resources. This information can be incorporated with other water use information to design operating procedures and discharge and drawdown regime scenarios for the Oldman River Dam project. Habitat enhancement downstream of the dam to compensate for losses due to upstream flooding has merit. Further study of the Oldman River between the dam and Fort MacLeod to determine which habitat enhancement measures would be most appropriate should be undertaken.

The Oldman River Dam will flood important coldwater stream fisheries for trout and mountain whitefish and replace them with an unproductive reservoir dominated by non-sport species and will cause changes in the fish populations upstream and downstream of the reservoir. The opportunities for effective mitigation are high enough that, if properly implemented, the overall impact of the Oldman River Dam on fisheries resources in the affected area might well be positive.

ACKNOWLEDGEMENTS

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1.0 INTRODUCTION

The Government of Alberta intends to construct a dam on the Oldman River north of the Town of Pincher Creek, commencing in 1986. The purpose of the dam, initially referred to as the Three Rivers Dam, but now known as the Oldman River Dam, is to create a reservoir with sufficient storage to provide a dependable water supply for downstream use and allow for expansion of irrigation in southern Alberta.

In anticipation of potential environmental impacts, the Planning Division of Alberta Environment is preparing an Environmental Mitigation/Opportunities Plan as part of the overall environmental impact assessment of the project. The plan has seven components and will be completed in three phases.

This report forms the fisheries element of the Phase 1 Overview of the Environmental Component of the Environmental Mitigation/Opportunities Plan.

The objective of the study and report was to provide an overview of the fisheries resources in the water bodies that will or may be impacted by the dam and reservoir. The study utilized available information to summarize aquatic habitat characteristics, fish distribution and population characteristics, sport fishery utilization and importance, identified

impacts and possible mitigation and identify areas for further study.

The Three Rivers Reservoir at full supply level will inundate approximately 17.5 km of the main stem of the Oldman River, 9.5 km of the Castle River and 6.5 km of the Crowsnest River and will cover an area of about 2300 hectares. Discharge regimes from the Three Rivers Dam will affect the main stem of the Oldman River downstream to the Lethbridge North Irrigation District (LNID) weir on the river and depending on the operation of both the dam and the weir, will affect flows as far downstream on the main stem as Fort MacLeod or beyond. Impacts are expected to occur upstream of the reservoir for a distance at least equivalent to the length of main stem channels inundated. The study area then consists of a 125 km section of the Oldman River main stem upstream from Fort MacLeod to near Maycroft, 26 km of the Castle River upstream from its mouth and 12 km of the Crowsnest River from its mouth to Lundbreck Falls. Figure 1 shows the study area and its provincial location.

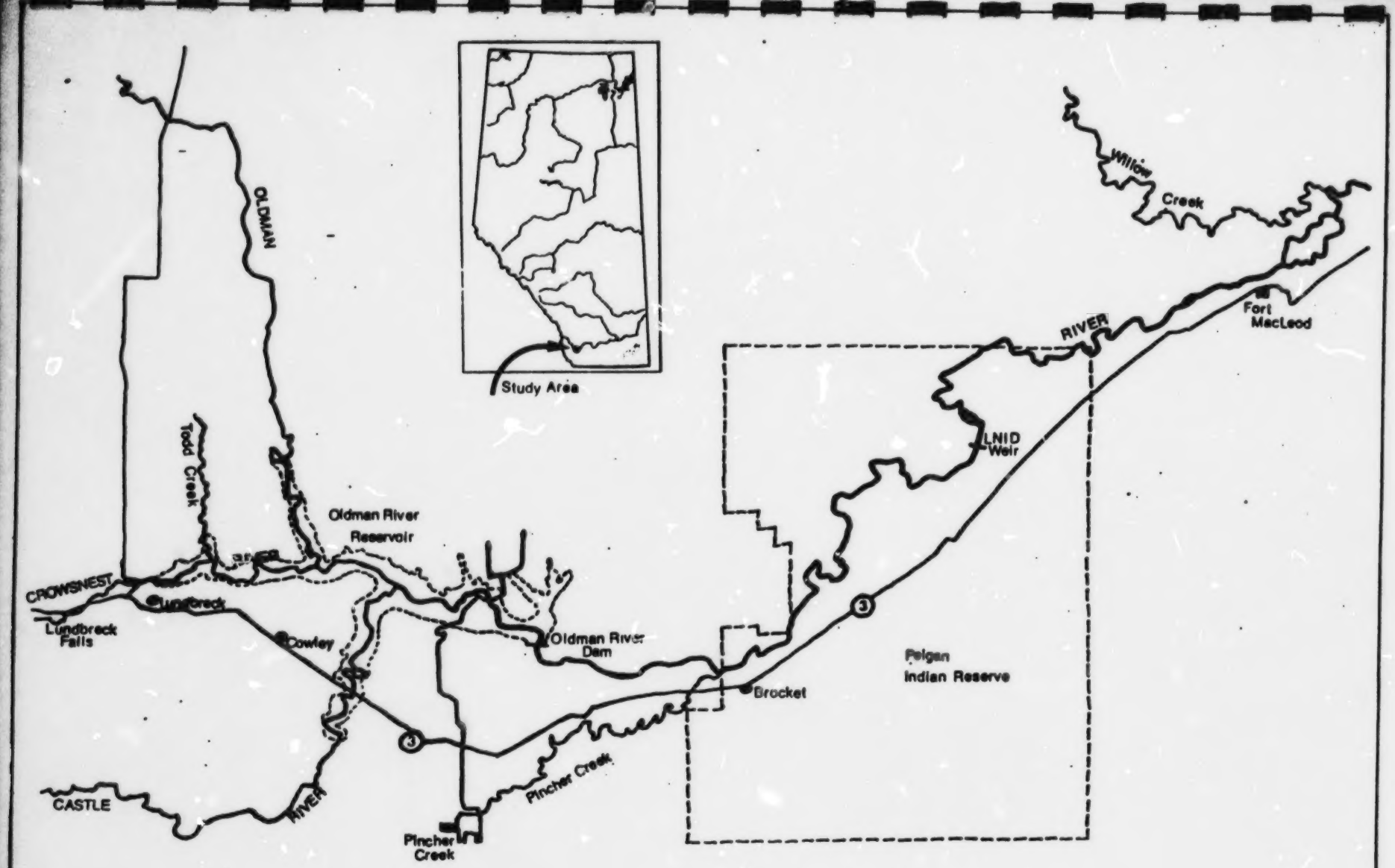

Figure 1. Oldman River Dam Study Area. 1: 250,000

2.0 METHODS

The fisheries overview study consisted of two functional components; a review and collation of existing pertinent information on the study area and preparation of a report.

Information searches were conducted in the Alberta Environment Library, the Alberta Environment, Planning Division Library and the Alberta Energy and Natural Resources Library in Edmonton and the Alberta Energy and Natural Resources, Fish and Wildlife Division Regional Library in Lethbridge.

There have been a number of major water resource related studies of the Oldman River Basin, eg. Oldman River Flow Regulation, Preliminary Planning Studies (Phase 1) commissioned by Alberta Environment and reported in 1975, followed by Phase 2 studies and reports for the Oldman River Basin Study Management Committee in 1978 and the reports on the public hearings conducted by the Environment Council of Alberta on the "Management of Water Resources Within the Oldman River Basin".

While these studies addressed the entire basin, portions of the various reports dealt with the Three Rivers site (Oldman River Dam) specifically as well as the fisheries resources in the basin. These reports along with pertinent stream survey reports prepared by the Fish and Wildlife Division of Alberta Energy and Natural Resources provided the bulk of

the information used to prepare this overview report.

A number of individuals with knowledge of fisheries and water resources of the study area were interviewed, including personnel of the Planning Division and Water Resources Division of Alberta Environment, the Fish and Wildlife Division of Alberta Energy and Natural Resources, residents of the study area and anglers using the study area streams.

The information was organized into six catagories, each receiving separate treatment in the report.

3.0 RESULTS

3.1 FISH POPULATION CHARACTERISTICS

Radford (1975) notes that the Oldman River main stem and tributaries upstream of Brocket are occupied by a coldwater fish species complex. Sport fishes in this complex include cutthroat trout, rainbow trout, bull trout, brown trout and mountain whitefish. Other large fish species able to adapt to the coldwater environment noted from within the study area include longnose suckers, white suckers, mountain suckers, lake whitefish and burbot. A recent record (O'Neil et al., 1982) indicates that northern redhorse suckers are present in the lower section of the coldwater zone.

Radford (1975) describes the section of the Oldman River main stem from Brocket to Lethbridge as a transition zone, occupied by both coldwater and coolwater species. Coldwater species in the transition zone include mountain whitefish, lake whitefish, the sucker species, burbot and rarely rainbow trout. The coolwater species complex present in this zone is comprised of walleye, northern pike, goldeye and sauger.

Table 1 presents a list of fish species reported from the study area and Figure 2 delineates the coldwater and coolwater zones.

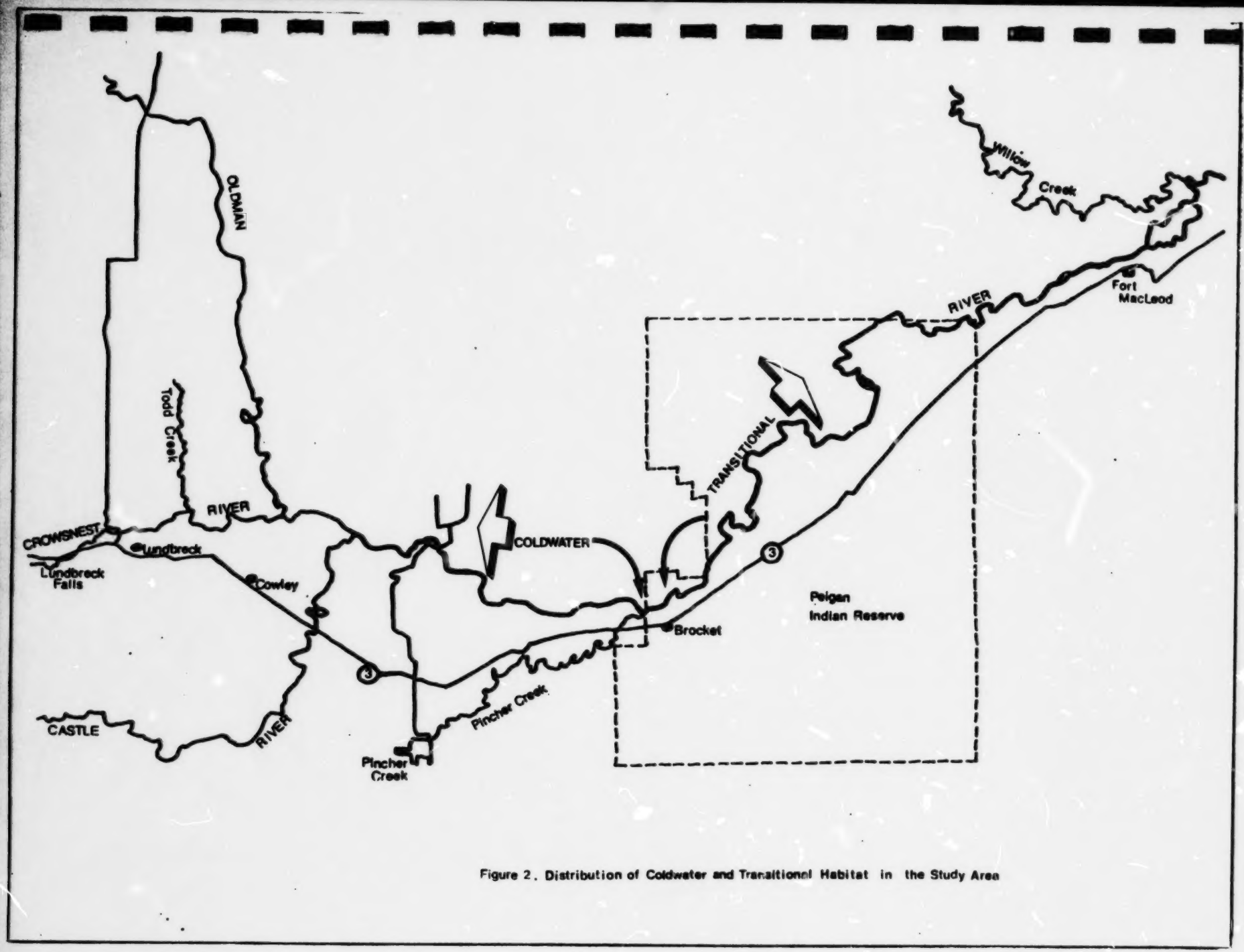

Figure 2. Distribution of Coldwater and Transitional Habitat in the Study Area

Table 1. List of Fish Species Reported from the Oldman River Dam Study Area.

Coldwater Sport Species	
Cutthroat trout	*Salmo clarki*
Rainbow trout	*Salmo gairdneri*
Brown trout	*Salmo trutta*
Bull trout	*Salvelinus confluentus*
Mountain whitefish	*Prosopium williamsoni*
Coolwater Sport Species	
Lake whitefish	*Coregonus clupeaformis*
Northern pike	*Esox lucius*
Goldeye	*Hiodon alosoides*
Sauger	*Stizostedion canadense*
Walleye	*Stizostedion vitreum*
Non-Sport Species	
White sucker	*Catostomus commersoni*
Longnose sucker	*Catostomus catostomus*
Mountain sucker	*Catostomus platyrhynchus*
Northern redhorse sucker	*Moxostoma macrolepidotum*
Burbot	*Lota lota*
Trout perch	*Percopsis omiscomaycus*
Spoonhead sculpin	*Cottus ricei*
Longnose dace	*Rhinichthys cataractae*
Lake chub	*Couesius plumbeus*

3.1.1 Mountain Whitefish

Mountain whitefish are the most abundant and widely distributed sport fish species in the study area (Longmore and Stenton, 1981; Radford, 1975). They are found from Lethbridge upstream in the Oldman River main stem to and beyond the study area boundary and are similarly distributed in the Crowsnest and Castle Rivers and in Todd Creek (Radford, 1975; Fitch, 1978; English, 1984). Figure 3 shows the distribution of mountain whitefish in the study area. There is no standing crop or population estimate information for mountain whitefish in

the study area. O'Neil et al. (1982) report catch per unit effort results for mountain whitefish in the main stem of the Oldman River at and below the Oldman River dam site exceeding 15 per 100 m for seining and 30 per km for electrofishing. Population and standing crop estimates for mountain whitefish in the Crowsnest River approximately 22 km above the study area range from 1129 mountain whitefish per kilometer to 2115 per kilometer with standing crops up to 375 kg/ha (Alberta Energy and Natural Resources, Fish and Wildlife Division records, Lethbridge). Mountain whitefish complete all phases of their life cycle within study area streams. They are highly migratory, moving upstream in spring and summer from overwintering areas to feeding areas and downstream in fall to spawning areas and overwintering areas (Davies and Thompson, 1976). IEC Beak Consultants (in preparation) reported on movements of mountain whitefish at the L.N.I.D. weir. They estimate that over 20,000 mountain whitefish migrated downstream in a 24 day period in October, 1984, probably seeking overwintering areas downstream. O'Neil et al. (1982) report that mountain whitefish made extensive use of the main stem of the Oldman River in a section extending 56 km below and 14 km above the Oldman River Dam site for rearing and feeding. They also note that the same reach of the Oldman River was used by adult mountain whitefish for spawning, with particularly intensive use of a section extending 8 km below and 6 km above the Oldman River Dam site. IEC Beak Consultants (in preparation) noted that the majority of mountain whitefish

examined during their study of movements in October at the L.N.I.D. weir had yet to spawn, suggesting that spawning would likely take place downstream of the weir. Fitch (1979) reports that all age classes of mountain whitefish were present in the Castle River at the study area boundary in August and September, suggesting that both rearing and feeding acitvities occur in the lower Castle River. Fitch (1978) also notes the presence of all age classes (up to six years) of mountain whitefish in the lower Crowsnest River (below Lundbreck Falls) and young of the year mountain whitefish in lower Todd Creek, a Crowsnest River tributary lying within the study area. English (1984) reports the capture of mountain whitefish in a section of the main stem of the Oldman River about 2 km below the Oldman River Dam site ranging from young of the year to 8 years old. He also notes that a high percentage of the 4 and 5 year old whitefish were sexually ripe in September, suggesting that spawning in the area was imminent.

3.1.2 Rainbow Trout

Rainbow trout distribution in the study area is delineated in Figure 3. The downstream limit of distribution in the main stem of the Oldman River appears to be between Brocket and Fort MacLeod (Radford, 1975; LGL Ltd. and the Sibbald Group, 1978; O'Neil et al., 1982; English, 1984; IEC Beak Consultants, in prep.). There is no population or standing crop information available for rainbow trout in the study area, however the Crowsnest River approximately 22 km above the

study area boundary supports from 748 to 1127 rainbow trout per kilometer (Alberta Energy and Natural Resources, Fish and Wildlife Div. records, Lethbridge). Little is known about the life history of the rainbow trout within the study area.

O'Neil et al. (1982) suggest that rainbow trout are unlikely to spawn in the main stem of the Oldman River in the study area but may utilize the Crowsnest River (below Lundbreck Falls) and/or the lower Castle River. As Fitch (1978, 1979) reports the presence of adult rainbow trout in the lower Crowsnest and Castle Rivers, spawning may occur in either or both rivers within the study area. O'Neil et al. (1982) report rainbow trout juveniles rearing in the Oldman River in a 25 km reach below the Oldman River Dam site. English (1984) reported the capture of 9 rainbow trout in a section of the Oldman River 2 km below the Oldman River Dam site; seven of these fish were immature 2 year olds. IEC Beak Consultants (in prep.) reported fall rainbow trout movements at the L.N.I.D. weir, noting that most movements were downstream, likely to overwintering areas. Fitch (1978) reported few juvenile rainbow trout were captured in the Crowsnest River below Lundbreck Falls however they were common in the Castle River at the study area boundary (Fitch, 1979).

3.1.3 Bull Trout

Bull trout are sporadically distributed in the Oldman River Dam study area (Figure 3). Radford (1975) indicates that bull trout occupy the Crowsnest River from Lundbreck Falls to its

mouth, the entire main stem of the Castle River and the main stem of the Oldman River down to the mouth of the Castle River. English (1984) reported the capture of 2 immature female bull trout at a site 2 km below the Oldman River Dam site and O'Neil et al. (1982) note the capture of a single bull trout at a site 5 km upstream of the dam site. IEC Beak Consultants (in prep.) report the capture of a bull trout in the L.N.I.D. irrigation canal. This individual apparently entered the canal at the L.N.I.D. weir. Little is known about bull trout life history in the study area. Adult bull trout are migratory between downstream overwintering areas and upstream spawning areas and juveniles rear, usually in their natal stream, for up to 5 years before reaching maturity (Allan, 1980). Longmore and Stenton (1981) suggest that bull trout may be rearing in the Crowsnest River below Lundbreck Falls.

3.1.4 Cutthroat Trout

Radford (1975) does not list cutthroat trout as being present in the streams in the Oldman River Dam study area, however Fitch (1978) reports the capture of cutthroat trout in the Castle River at the study area boundary and IEC Beak Consultants (in prep.) report the capture of a single cutthroat trout at the L.N.I.D. weir on the Oldman River. Cutthroat trout appear to occur rarely in the Oldman River Dam study area.

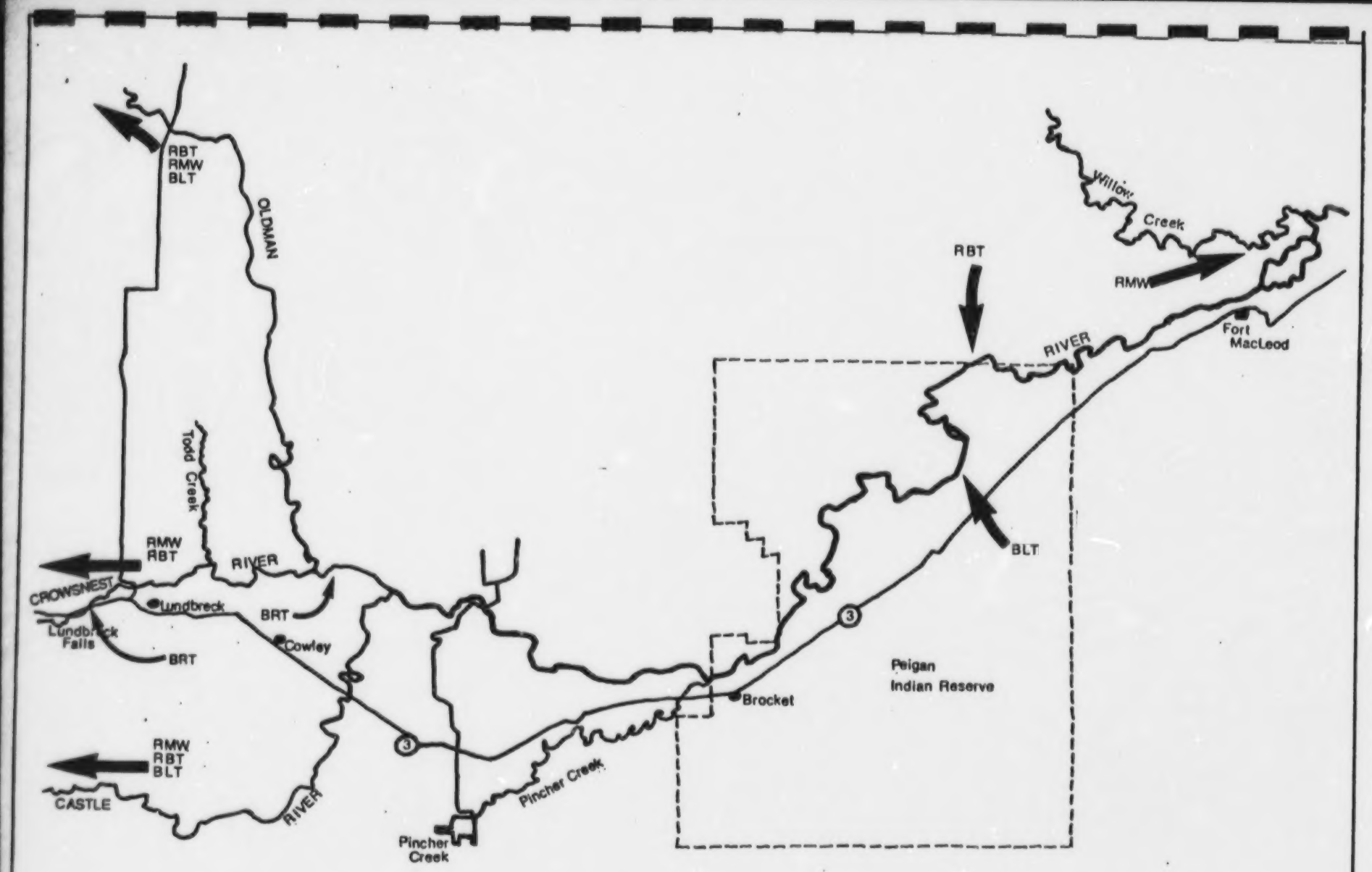

Figure 3. Distribution of mountain whitefish (RMW), rainbow trout (RBT), bull trout (BLT), and brown trout (BRT) in the study area

3.1.5 Brown Trout

Radford (1975) reported that brown trout were introduced into the Crowsnest River below Lundbreck Falls, however their status was unknown. Fitch (1978) notes that brown trout were introduced into the Crowsnest River in 1967, 1968 and 1969 and reports the capture of brown trout aged 2, 3 and 5 years in 1976, suggesting that some natural reproduction had occurred. Anglers report the occasional capture of brown trout in the Oldman River below the mouth of the Crowsnest River. Brown trout distribution in the study area is shown on Figure 3.

3.1.6 Lake Whitefish

Lake whitefish are a largely lacustrine species and are found in several reservoirs downstream of the Oldman River Dam study area (Radford, 1975). Lake whitefish are common in the main stem of the Oldman River up to Fort MacLeod (Alberta Energy and Natural Resources, Fish and Wildlife Div. records, Lethbridge). O'Neil et al. (1982) report the capture of an adult lake whitefish 15 km above the L.N.I.D. weir on the Oldman River. IEC Beak Consultants (in prep.) report both upstream and downstream movements of lake whitefish in October at the L.N.I.D. weir, totalling 138 fish. Twenty-five percent of these lake whitefish were mature and several males were ripe, suggesting that some spawning may occur in the Oldman River below the L.N.I.D. weir. Lake whitefish distribution in the study area is shown on Figure 4.

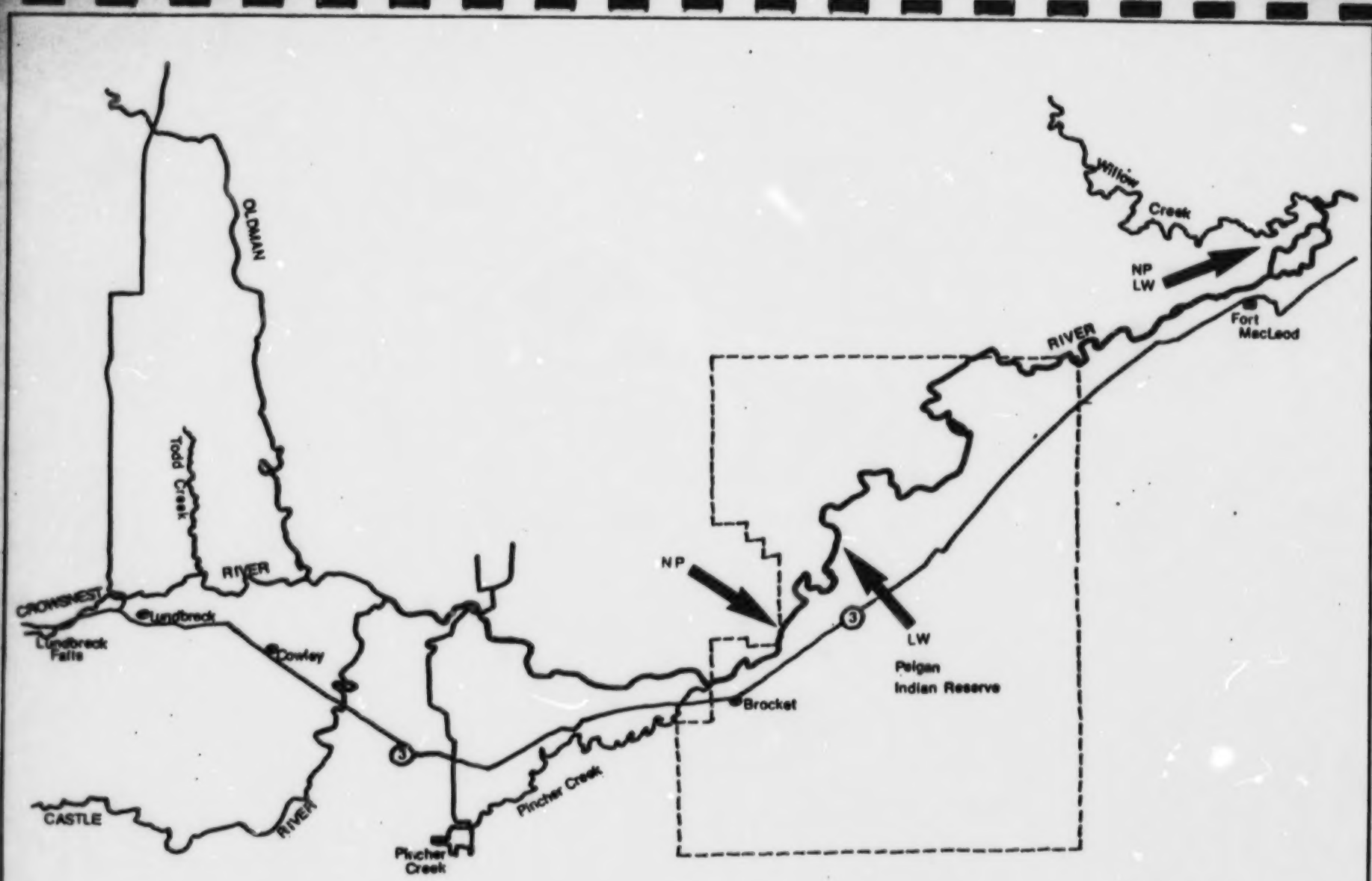

Figure 4. Distribution of northern pike (NP) and lake whitefish (LW) in the study area

3.1.7 Northern Pike

Radford (1975) gives the upper distribution limit for pike in the Oldman River system as the Fort MacLeod area, however O'Neil et al. (1982) captured 2 northern pike approximately 20 km above the L.N.I.D. weir on the Oldman River. One of these pike was a ripe female, suggesting that northern pike spawning may occur in the Oldman River main stem within the study area although it is probably not common. IEC Beak Consultants (in prep.) report that pike movement in the fall at the L.N.I.D. weir is predominantly downstream, presumably to overwintering areas. They enumerated a total of 13 pike moving up or down at the L.N.I.D. weir. Figure 4 shows the distribution of northern pike in the study area.

3.1.8 Walleye

Radford (1975) suggests that walleye occur in the Oldman River only below the mouth of the St. Mary River, however recent data obtained in 1983 (Alberta Energy and Natural Resources, Fish and Wildlife Div. records, Lethbridge) indicates that walleye are present at least as far upstream as Fort MacLeod. Little is known about the walleye in the Oldman River other than that they are present sporadically from late May through October downstream of Fort MacLeod.

3.1.9 Goldeye

Goldeye do not occur in the study area, although they have been recorded at Monarch on the Oldman River (Alberta Energy

and Natural Resources, Fish and Wildlife Div. records, Lethbridge) and may have been present historically in Willow Creek (W. English, personal communication). They would be present only during spring and summer, migrating downstream to overwintering areas in the fall (Longmore and Stenton, 1981).

3.1.10 Non-Sport Species

White suckers, longnose suckers and mountain suckers are common to abundant throughout the study area (Radford, 1975). The distribution of these three species is shown on Figure 5. O'Neil et al. (1982) report that all three species apparently spawn and rear in the main stem of the Oldman River from the mouth of the Crowsnest River to a point about 15 km below the L.N.I.D. weir. They also recorded the capture of a spent northern redhorse sucker a short distance above the L.N.I.D. weir, suggesting that spawning by this species may be occurring in this section of the Oldman River. This capture extends the known range of the northern redhorse sucker approximately 40 km upstream in the Oldman River system.

Burbot are ubiquitous at low population levels as far upstream in the study area as the mouth of the Crowsnest River (Radford, 1975; English, 1984). O'Neil et al. (1982) recorded the capture of burbot juveniles in the main stem of the Oldman River below the Oldman River Dam site and suggested that burbot may utilize this area for rearing.

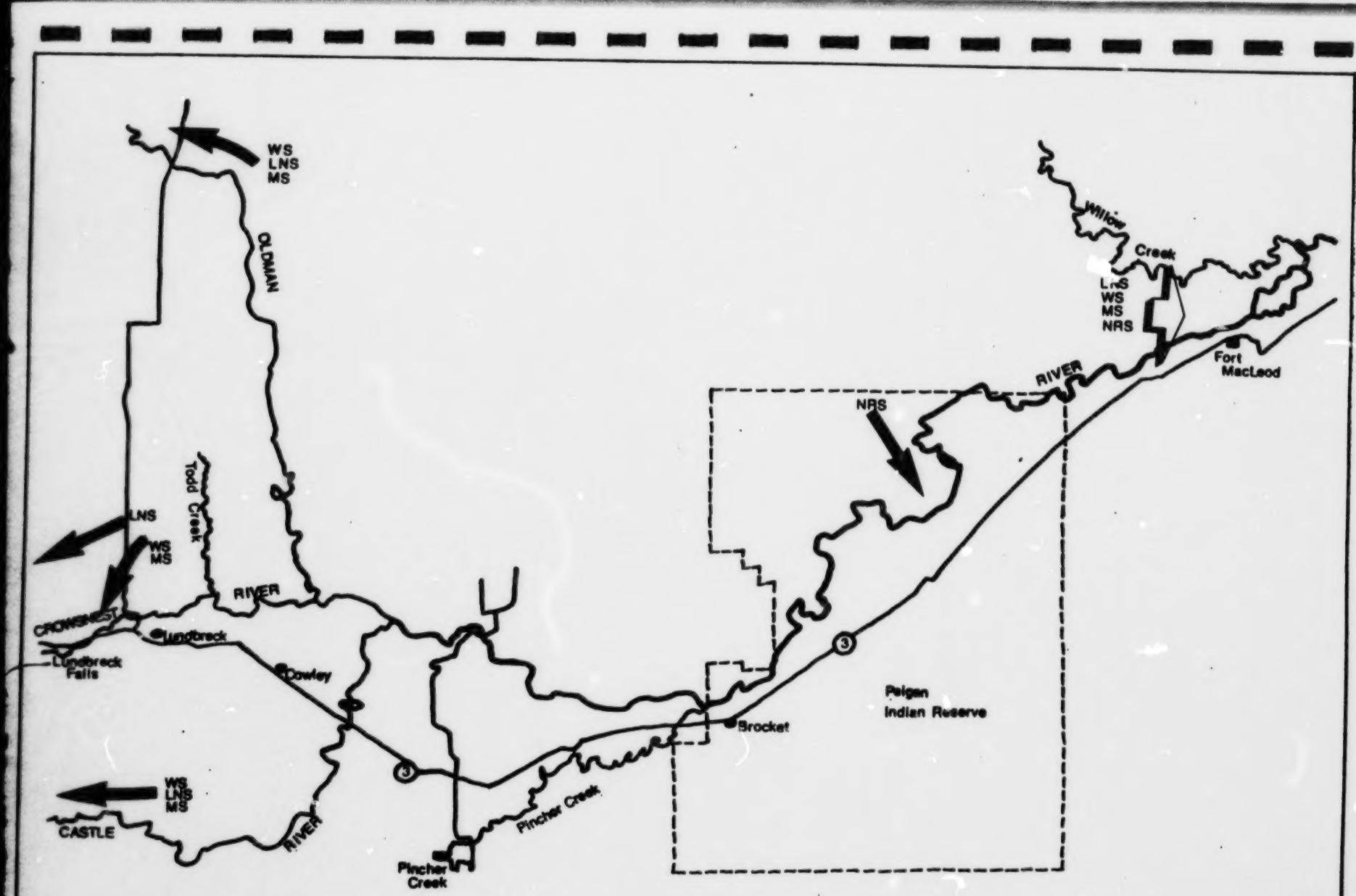

Figure 5. Distribution of longnose(LNS), white(WS), mountain(MS) and northern redhorse(NRS) suckers in the study area

Radford (1975) indicates that trout perch, lake chub and longnose dace are present in the study area streams and O'Neil et al. (1982) and English (1984) add spoonhead sculpins to this list. Little is known about the life cycles of these species in the study area.

3.2 HABITAT

The Oldman, Castle and Crowsnest Rivers all have Class 1 Sport Fish Capability ratings (no significant limitations on sport fish production) under the Canada Land Inventory system (Fitch, 1978; 1979; English, 1984). Miller and MacDonald (1950) examined the Crowsnest River, determining that the most productive habitat in the river was in that section below Lundbreck Falls. Habitat characteristics of the lower Castle River, the lower Crowsnest River and the Oldman River main stem from above the mouth of the Crowsnest River downstream to the Oldman River Dam site have been described by Radford (1975), Fitch (1979) and English (1984). Additional habitat inventory data for the Oldman River from the L.N.I.D. weir to the City of Lethbridge is available in the files of the Fish and Wildlife Division in Lethbridge. These habitat inventories were made utilizing similar methods and the results are summarized in Table 2.

O'Neil et al. (1982) described mountain whitefish spawning habitat in a section of the main stem of the Oldman River extending 37 km below and 13 km above the Oldman River Dam. The depth and velocity of water and the composition of the substrate in this section are similar to those noted in Table 2, suggesting that mountain whitefish spawning habitat is widely distributed in the study area. O'Neil et al. (1982) also described rearing habitat for young-of-the-year mountain whitefish as lower velocity riffle/run complexes in side

Table 2. Summary of the habitat characteristics for river reaches in the Oldman River Dam Study area. Sources:(1) - Radford, 1975;(2) - Fitch, 1979;(3) - Fish and Wildlife Div. files.

Stream Channel Characteristics	Crowsnest River	Castle River		Oldman River		
	lower 15 km (1)	lower 13 km (1)	lower 34 km (2)	Crowsnest R. to Castle R. (1)	Castle R. to Oldman Dam (1)	LNID weir to Fort MacLeod (3)
Average width(m)	25.8	29.4	29.5	26.7	46.7	60.8
Average depth(cm)	35.6	66.0	45.2	81.8	81.8	44.2
Riffle area(%)	90	74	72	64	64	68
Pool area(%)	10	26	28	36	36	32
Pool quality(%)						
class 1	14	50	46	100	100	n/a
class 2	0	7	25	0	0	n/a
class 3	0	0	6	0	0	n/a
class 4	67	43	17	0	0	n/a
class 5	19	0	6	0	0	n/a
Substrate types(%)						
boulder	19	24	14	29	20	3
rubble	48	57	54	54	65	84
gravel	21	13	18	10	14	9
sand/silt	10	2	5	0	1	4
other	2	4	9	7	0	0
Unstable banks(%)	7	13	26	0	8	35
Gradient(m/km)	10.3	11.2	4.5	4.4	6.9	1.7
Average velocity (cm/sec.)	67.1	57.9	86.0	121.9	67.1	56.0

channels and large quiet backwaters and noted that juveniles preferred riffle/run complexes in the main channel and side channels. Thompson (1974) describes similar habitats utilized by young-of-the-year and juvenile mountain whitefish in the Sheep River, Alberta. Reference to Table 2 suggests that there may be substantial areas of juvenile mountain whitefish rearing habitat available in the Oldman River Dam study area, however the shallow backwater pools preferred by young-of-the-year appear to be relatively scarce.

LGL Ltd. and the Sibbald Group (1978) gave criteria for salmonid spawning habitat in the upper Oldman River suggesting that such habitat is fairly common in the Oldman River above the Oldman River Dam site. Keith Consulting and Angus Butler (1975) state that the mouth of the Castle River offers high quality spawning habitat for coldwater salmonids.

Radford (1975) and English (1984) indicate that all pools measured in the Oldman River main stem between the mouth of the Crowsnest River and the site of the Oldman River Dam were suitable for overwintering, however O'Neil et al. (1982) stated that overwintering capability in the main stem of the Oldman River between the mouth of the Crowsnest River and the L.N.I.D. weir was moderate. The lower Castle River appears to have a fairly high overwintering potential, however the lower Crowsnest River appears to have fairly low capability (Table 2.).

O'Neil et al. (1982) suggest that the majority of the substrate in that section of the Oldman River within 10 km of the Oldman River Dam site is generally too coarse for rainbow trout spawning. Table 2 indicates that gravel comprises only 12 % of the substrate in the main stem of the Oldman River between the mouth of the Crowsnest River and the Oldman River Dam site. McCart (1978) suggests that rainbow trout in the main stem of the Oldman River below the mouth of the Crowsnest River may be migrating upstream to spawn in more suitable habitat in the Crowsnest River, the Castle River and Pincher Creek. Table 2 indicates that there may be more suitable substrates available for rainbow trout in the lower Castle and Crowsnest Rivers.

The presence of juvenile brown trout suggests that some brown trout spawning may be taking place in the lower Crowsnest River. Water velocity and substrate size criteria for brown trout spawning habitat given by Shirvell and Dungey (1983) and Reiser and Wesche (1977) fall within the range of parameters for these characteristics in the lower Crowsnest River, however the total area of suitable sized substrate deposits may be limited.

Spawning habitat for the 4 species of suckers appears to be abundant in that section of the Oldman River between the mouth of the Crowsnest River and the L.N.I.D. weir, however suitable rearing habitat, ie. shallow backwater areas, is not common

(O'Neil et al., 1982).

O'Neil et al. (1982) note that pike spawning and rearing habitat in the main stem of the Oldman River between the mouth of the Crowsnest River and the L.N.I.D. weir is rare.

3.3 FISHERIES RESOURCE UTILIZATION

The study area lies within Water Survey of Canada watershed units 5AA and 5AB (Radford, 1975). These units comprise the upper Oldman River Basin above Monarch. In 1968 and 1969 unit 5AA supported 96,420 and 108,549 angler days respectively (Miller, 1971) and was estimated to support 137,490 angler days in 1975 (Radford, 1975). Unit 5AA is among the second or third most intensively utilized unit in the province (Longmore and Stenton, 1981). Radford (1975) notes that unit 5AB supported an approximate average of 15,880 angler days annually from 1968 to 1970 and estimated 51,735 angler days of use in 1975.

O'Neil et al. (1982) estimated that 290 angler days of fishing occurred during May, June and July, 1982 on a section of the Oldman River between the Crowsnest River and the L.N.I.D. weir and suggested that actual use could easily be 2 or 3 times greater. A single site located about 5.5 km below the Oldman River Dam site (Summerview Bridge) supported an estimated 217 angler days of use in October, 1984. Mountain whitefish congregate in a large pool at this site in September and October, attracting large numbers of anglers.

Fish and Wildlife Officer creel survey reports (Alberta Energy and Natural Resources, Fish and Wildlife Div. records, Lethbridge) reveal that angling activity is concentrated at accessible sites along the three major rivers throughout the

study area. Angling activity appears to increase in an upstream direction and is generally higher in September and October, coincident with seasonal concentrations of mountain whitefish.

Beak Consultants and Landplan Associates (1975) note that angling activity on the main stem of the Oldman River, including that section within the Oldman River Dam study area, is concentrated at major access points.

Longmore et al. (1982) report that a total of 49,698 anglers spent 587,773 days angling in the Southern Administrative Region of the Fish and Wildlife Division of Alberta Energy and Natural Resources in 1980. The Oldman River Dam study area comprises only about 3 % of the land area of the Southern Region, however it is located in the western half of the Region where the majority of angling takes place (Longmore and Stenton, 1981).

Alberta Environment (1984) describes the Oldman River main stem above Brocket as one of the most intensively fished river reaches in the South Saskatchewan River Basin.

It should be noted that public access for fishing is restricted on approximately 38 km of the Oldman River main stem located within the Peigan Indian Reserve.

3.4 IMPORTANCE OF THE SPORT FISHERY

Portions of the major rivers in the Oldman River Dam study area have local, regional, provincial and even international importance as sport fisheries. Radford (1975), Longmore and Stenton (1981) and Keith Consulting and Angus Butler (1975) attach provincial importance to the fishery in the Oldman River above the mouth of the Castle River.

Results of creel census reported by O'Neil et al. (1982) suggest that the fishery on the Oldman River between the mouth of the Crowsnest River and the L.N.I.D. weir is of local importance; the majority of the anglers censused (88%) resided within 50 km of the Town of Pincher Creek. Limited data available from Fish and Wildlife Officer reports suggests that anglers utilizing the Oldman River between the L.N.I.D. weir and the City of Lethbridge are predominantly local residents.

Beak Consultants and Landplan Associates (1975) note that angling is a popular outdoor activity in the upper Oldman River basin, inclusive of the Oldman River Dam study area, attracting anglers from throughout the province. Walls (1976) rates the Crowsnest River, including the section below Lundbreck Falls, as having a very high capability for water oriented outdoor recreation, a major component of which is angling. Longmore et al. (1982) report that in 1980, 55% of the anglers utilizing the fisheries resources of the Southern Administrative Region of the Fish and Wildlife Division of

Alberta Energy and Natural Resources resided outside of the Region, implying that the fisheries resources of the region attract large numbers of people from elswhere in the province.

The Crowsnest River has recently developed an international reputation as a trout fishery; it is described in Sports Afield magazine (1984) as "Alberta's best rainbow trout stream".

3.5 IMPACTS OF THE OLDMAN RIVER DAM AND RESERVOIR

3.5.1 Construction

McCart (1978) described four potential areas of impact that might affect fish populations during construction of a dam on the Oldman River.

1. Sediment Loads

   Increased sediment loads will result from reservoir clearing, access road construction, instream activities, site preparation and material extraction. Increased turbidity will decrease primary production and degrade benthic invertebrate habitat. The eggs and fry of fish, if present, will be jeopardized by sedimentation due to construction. As flushing flows may not be released by the dam after construction, sediments deposited due to construction may have long term impacts.

2. Water Pollution

   Fuels, lubricants, other chemicals and sewage associated with any large construction project, especially when located on or adjacent to a water body, are potential sources of water pollution, affecting aquatic organisms directly as toxicants or indirectly by increasing biochemical oxygen demand.

3. Barriers to Migration

   Diversion tunnels to carry stream flow during dam construction will operate at velocities exceeding the swimming capabilities of fish and will therefore constitute a barrier to fish movement. Fish may accumulate in large

numbers below these barriers and if this occurence is due to spawning migrations, the delay may cause spawning failures. In these circumstances fish are also highly susceptible to predation.

4. Use of Explosives

Explosives are likely to be utilized during the construction of a dam and can cause significant mortalities of fish.

O'Neil et al. (1982) also identified four potential impacts of dam construction for the now defunct Brocket Dam proposal, which was to have been located about 25 km downstream of the Oldman River Dam site, which were similar to those previously reviewed. They also noted that reservoir filling often takes place during the construction phase and that reservoir filling is treated separately from dam operation and is not therefore subject to discharge regime guidelines. As a consequence, down stream flows are often severely restricted during the reservoir filling period.

3.5.2 Upstream Impacts

Potential impacts upstream of the Oldman River Reservoir will be manifested primarily by changes in fish species composition and densities. Based on predictions made by McCart (1978) and Radford (1975) that suckers will dominate the reservoir fish populations, it is reasonable to expect that suckers will become more abundant upstream of the reservoir, particularly

during spring migrations and spawning activities. Erman (1973) found that suckers which had been a minor component of the fish population of a stream prior to impoundment dominated both the impoundment subsequently created on the stream and the stream above the impoundment and that mountain whitefish and trout concurrently decreased in the stream above the impoundment.

Should such a phenomenon occur in the Oldman River Dam study area, it would be most apparent in the section of the Crowsnest River isolated between Lundbreck Falls and the reservoir.

3.5.3 Impacts of Impoundment

At full supply level the Oldman River Reservoir will flood approximately 17.5 km of the Oldman River, 9.5 km of the lower Castle River and 6.5 km of the lower Crowsnest River. Radford (1975), Keith Consulting and Angus Butler (1975), LGL Ltd. and the Sibbald Group (1978) and McCart (1978) all predict that the inundation of this high quality coldwater riverine habitat will displace the mountain whitefish, rainbow trout, bull trout and brown trout that currently utilize the area for spawning, rearing, feeding and/or overwintering. Radford (1975) and McCart (1978) further predict the lacustrine reservoir habitat will be dominated by sucker species, principally white suckers, with mountain whitefish and perhaps a few brown trout making up the remainder of the fish population.

McCart and Jones (1974) predicted a similar change in species composition would take place in the reservoir (Glennifer Lake) formed behind the Dickson Dam on the Red Deer River in central Alberta. Nelson (1965) described changes in species composition in 3 reservoirs in western Alberta, noting that sucker species ultimately predominated, with mountain whitefish making up the majority of the remaining fish fauna. Radford (1975) notes that white suckers constitute virtually the entire naturally occurring fish population in Chain Lakes Reservoir, located on a tributary of the Oldman River in western Alberta. Gebhards (1975) states that reservoirs rarely develop wild (naturally reproduced) trout populations, the lack of spawning/rearing areas and drawdown being the most frequently cited limiting factors.

Newly impounded reservoirs exhibit high levels of productivity initially due to the availability of nutrients from inundated terrestrial areas and then decline in productivity to a level largely determined by nutrient input, water temperatures and resevoir operating regimes (Neel, 1963; Chamberlain, 1972; Kimsey, 1957). Radford (1975) and McCart (1978) predict that with the anticipated flushing rates and temperatures a similar phenomenon is likely to occur in the Oldman River Reservoir.

Radford (1975) estimates ultimate fish production for the Oldman River Reservoir at about 4 kg/ha annually, or approximately 10,000 kg/year, about 30% of which would be sport fish

consisting mostly of mountain whitefish and a few trout. Assuming that the area of river channels which will be inundated supports a standing crop of about 300 kg/ha (based on standing crop data for the Crowsnest River given earlier in this report) and that, conservatively, 20% of the standing crop can be harvested annually, then the river channel that will be inundated is capable of producing about 60 kg/ha annually, or about 15 times more than the Oldman River Reservoir. Although the reservoir is some 20 times greater in area than the area of river that will be flooded , it will likely be capable of producing less than half as much sport fish annually (3000 kg for the reservoir, 6600 kg annually for the flooded river area).

Fish populations may also be limited by other physical characteristics of the Oldman River Reservoir. There is no information on probable drawdown regimes for the Oldman River Reservoir, however Clements (1973) describes the effects of drawdown regimes for the St. Mary Reservoir, a main stem irrigation reservoir in the Oldman River Basin. He reports that a normal annual fluctuation of about 6.1 m reduces the surface area of St. Mary Reservoir by 46% and exposes 1670 ha of barren mud flats. The reservoir reaches near full supply level in June or July and drawdown continues until October. Levels remain low until the following April. Clements (1974) reports similar drawdown regimes and effects for the Waterton Reservoir. Such regimes preclude the establishment of a stable

littoral community and McCart (1978) notes that benthic invertebrate production is severely reduced under these conditions. Fish species that require stable, shallow water near shore for spawning frequently experience incubation and/or hatching failures or high fry mortalities under fluctuating water level regimes. Post spawning increases in water depth over eggs may result in reduced temperatures affecting incubation success and post spawning decreases may expose eggs and fry to dehydration or freezing (Patriarche and Campbell, 1958; McCaig et al., 1960; Jester, 1971). Fluctuating water levels also can cause increased shoreline erosion and subsequent near shore sediment deposition which results in losses of coarse substrate types which are preferred by lake whitefish, lake trout and walleye for spawning and may smother incubating eggs (Machniak, 1975a; 1975b; 1975c; June, 1971; Fudge and Bodaly, 1984). Main stem reservoirs act as sediment traps and their upper reaches and tributary embayments accumulate sediment deposits rapidly, replacing former substrates with a uniform layer of fine material which is generally unproductive of benthic invertebrates, unsuitable for fish spawning or rearing and highly susceptible to wind and water erosion.

In addition to supporting a sport fishery with low productivity and species diversity, the Oldman River Reservoir fishery would be largely restricted to shore as the strong prevailing winds would likely make boating very dangerous (ECA, 1979).

D. A. Westworth and Associates (1982) suggested that due to dangerous ice conditions, ice fishing in the reservoir formed by the Dickson Dam (Glennifer Lake) would be hazardous and might have to be prohibited; this circumstance may also occur at the Oldman River Reservoir.

3.5.4 Downstream Impacts

There is a considerable volume of literature related to flow regulation in the Oldman River Basin, some referring specifically to the Oldman River Dam, however there is little information on expected discharge regimes from the dam.

McCart (1978) suggests that flows below the Oldman River Dam may be drastically reduced, as is the case below the St. Mary and Waterton Dams, which could eliminate downstream populations of rainbow trout. As the initial design for the Oldman River Dam (Three Rivers site) by the P.F.R.A. (1975) allowed for less than 1 cms riparian flows, McCart's suggestion is not impossible.

Most water resources/fisheries related studies in the Oldman River Basin (Acres, 1978; Keith Consulting and Angus Butler, 1975; Lombard North and the Sibbald Group, 1978; McCart, 1978; Radford, 1975; UMA, 1978) suggest that the Oldman River Dam will have sufficient storage to maintain or augment natural flows in the Oldman River main stem; the terms of reference for this study reinforce the foregoing assertion. It is

assumed then that the Oldman River Dam will capture and store excess discharge, which normally occurs in April, May, June and/or July, and pass at least natural flows, perhaps even augmented flows, for the remainder of the year as well as delivering water to the L.N.I.D. weir and canal during the irrigation season. The Oldman River main stem from the Oldman River Dam downstream to Fort MacLeod, and perhaps beyond, will be subject to two different flow regimes. The section of channel between the dam and the L.N.I.D. weir will carry normal or perhaps augmented flows for most of the year (October to April), reduced flows in May, June and/or July and increased flows (by as much as 43 cms) while delivering water to the L.N.I.D. weir and canal during the irrigation season from July to September. It is expected that the section below the L.N.I.D. weir will carry near normal or augmented flows for much of the year, however peak flows are expected to be much reduced. Because of diversions at the L.N.I.D. weir, flows below the weir have been reduced to less than 1 cms in the past severely jeopardizing fish survival downstream (IEC Beak Consultants, in prep.). If flow augmentation is incorporated into the operating regime of the Oldman River Dam, benefits would accrue to the downstream fisheries and the dam would have a positive downstream impact in this case. There are however other potential downstream impacts other than flows.

Changes in substrate composition in the river channel immedia-

tely below the Oldman River Dam are likely to occur. Bed load accretion from upstream is virtually eliminated, however bed load movement is usually increased immediately below dams due to increases in water velocity. This normally results in the transport of gravel and fines further downstream, leaving the channel immediately below the dam paved with cobbles and boulders (McCart and Jones, 1974). Lateral channel migration may occur immediately the dam, however because the because the dam will reduce peak flows, long term lateral migration will likely be reduced further downstream. Doyle and Thompson (1979) reported some sorting of substrate materials and changes in channel morphology in the North Saskatchewan River below the Bighorn Dam in Alberta, but noted that the changes were minor in extent. While some changes in substrate composition and channel morphology can be expected immediately below the Oldman River Dam, they will likely be minor.

Hypolimnetic (low level) withdrawal has been designed for the Oldman River Dam (P.F.R.A., 1975; Klohn Leonoff, 1978) and in the first few years of operation releases of oxygen deficient and possibly toxic water from the hypolimnion may cause fish kills downstream of the dam (McCart, 1978; Radford, 1975; Wright, 1967). Hypolimnetic withdrawal generally depresses temperature regimes downstream of dams and, because a large reservoir acts as a nutrient sink, increases nutrient levels and productivity downstream (Neel, 1963). Some authors consider these phenomena as negative impacts (McCart, 1978;

Wright, 1967) because coolwater fish habitat and species composition and invertebrate communities are altered. There are however examples where such conditions (lower temperatures, high productivity) in tail waters have resulted in the establishment of high quality coldwater salmonid fisheries (Pfitzer, 1967; 1975; Wiley and Mullen, 1975). It appears that hypolimnetic withdrawal might lower temperatures sufficiently to displace or at least alter use by coolwater species in the Oldman River below the dam, however the mountain whitefish and rainbow trout present below the dam may be able to take advantage of the cooler water temperatures and higher productivity. It is difficult without operating regime scenarios to predict how far downstream temperature and productivity effects might be manifested.

The Oldman River Dam will act as a barrier to fish attempting to move upstream. Neel (1963) and Geen (1974) note that fish frequently accumulate below dams where they are subject to stress and injury. If fish are attempting to reach spawning habitat, they may experience spawning failures and consequent mortality before they can find alternative spawning sites below the barrier. Concentrations of fish below dams are also very susceptible to harrassment and capture.

According to the dam and appurtenant structures layout given by Klohn Leonoff (1978) there will be about 300 m of Oldman River channel between the bottom of the spillway and the

delivery tunnel outlet channel. When the spillway gates are closed after excess water is passed over the dam, the 300 m section of channel will drain and fish may be trapped between the bottom of the spillway and the tunnel outlet.

Normally spillways for high dams create gas supersaturation problems at their outlets, however because a flip bucket energy dissipator has been incorporated into the design of the Oldman River Dam (Klohn Leonoff, 1978), gas supersaturation should not occur.

Overall, assuming that the Oldman River Dam will not severely reduce flows and will pass at least normal flows and that these flows will also pass the L.N.I.D. weir, the downstream impacts of the dam are likely to be positive.

3.6 MITIGATION

McCart (1978) has described a number of mitigative measures to reduce the impact of the Three Rivers Dam and his report was extensively referred to for this section. Information on file with the Fish and Wildlife Division of Alberta Energy and Natural Resources contained some suggestions for mitigation as well. Mitigation recommended for the Brocket Dam, which was to have been located on the Oldman River 25 km downstream of the Oldman River Dam, by O'Neil et al. (1982) and for what is now the Dickson Dam on the Red Deer River by McCart and Jones (1974) and D. A. Westworth and Associates (1982) may be suitable for the Oldman River Dam.

3.6.1 Mitigating Construction Impacts

A construction procedures and timing plan for the Oldman River Dam should include measures to reduce the introduction of fine materials into the river and to control the use of explosives, particularly when fish are more sensitive to impacts. Although stands of trees are not extensive in the river valley that will be inundated, they should still be cleared to minimize debris accumulations, improve navigation and improve aesthetics. Only the trunks and branches should be removed; stumps should be left in place to provide cover for fish and substrate for benthic invertebrates. Any construction procedures plan should include guidelines for sewage and refuse disposal and fuel, oil and/or toxic chemical spill controls. Diversion of flow from the natural channel to diversion tunnels to allow

dam construction should be done in such a manner as to reduce the probability of fish being stranded in the dewatered channel, ie. seasonal timing and rate of flow reduction. It may be prudent to establish a contingency plan for the removal of fish from the dewatered channel. Reservoir filling should be implemented and timed so that an acceptable downstream riparian flow is maintained.

3.6.2 Mitigation of Impacts Upstream of the Reservoir

The major impact upstream of the Oldman River Reservoir is likely to be an increase in the seasonal abundance of coarse fish, predominantly white suckers. Coarse fish control through poisoning and/or capture and removal programs is generally cost prohibitive and effective only in the short term (D. A Westworth and Associates, 1982). Seasonal concentrations of coarse fish will be most evident in the section of the Crowsnest River isolated between Lundbreck Falls and the reservoir. A removal program may be justifiable in this section should large concentrations of white suckers or other coarse species occur in the future. Poisoning is precluded because of the threat to downstream salmonid populations, water quality implications and costs. The use of barriers to deny entry to the section from the reservoir would also bar desireable salmonid species.

3.6.3 Mitigation for the Oldman River Reservoir

Fluctuations in reservoir levels have been identified as a

potentially significant limiting factor on fish production in the Oldman River Reservoir, however a drawdown regime to reduce this impact would likely interfere with the stated purpose of the dam and reservoir, that of assuring adequate downstream flows for multiple uses.

Some short term mitigation to compensate for losses of high quality salmonid fisheries due to inundation may be realized by stocking fish in the reservoir for the first 2 or 3 years after filling. Because of their availability and prior presence, rainbow trout are probably the best choice. These fish can take advantage of the high levels of productivity anticipated in the first few years of reservoir life, producing an excellent, all be it short term, reservoir fishery. A successful fishery was created under similar circumstances in Glennifer Lake (Dickson Dam) on the Red Deer River (D. Lowe, pers. comm.). Utilization of such a fishery in the Oldman River Reservoir may be limited due to wind during the open water season and by ice conditions in winter. It would appear that the introduction of other species such as lake whitefish, lake trout or walleye to establish a self-reproducing sport fish population has only a moderate probability for success.

Chances of successful spawning and incubation for lake whitefish and lake trout could be improved by maintaining static reservoir water levels during the late fall and winter, however static levels may be precluded because of the intended uses of reservoir storage and could reduce mitigative opportunities downstream of the dam.

The success of habitat enhancement such as creating areas of suitable spawning substrate or construction of cover/refugia devices for fish in the reservoir would again be dependant on drawdown regimes. When drawdown regime scenarios for the Oldman River Reservoir become available, such measures can be more accurately evaluated.

A compensatory mitigative measure that may have merit is the enhancement of habitat for salmonids in the 3 km section of the Crowsnest River isolated between Lundbreck Falls and the reservoir and in sections of the Oldman and Castle Rivers extending for perhaps 10 km above the reservoir full supply level. In-stream enhancement of spawning, rearing and resting habitats for brown trout, rainbow trout and mountain whitefish could increase recruitment to the reservoir, thereby enhancing the reservoir sport fish population. D. A. Westworth and Associates (1982) addressed a similar potential for brown trout recruitment to Glennifer Lake (Dickson Dam) on the Red Deer River.

The improvement of productivity through fertilization has been carried out in lakes, however reservoirs with high flushing rates do not benefit as the nutrients are transported out of the system before they can be utilized (D. A. Westworth and Associates, 1982).

3.6.4 Mitigation of Downstream Impacts

It has been assumed in this report that as the stated purpose of the Oldman River Dam is to provide a dependable water supply for multiple downstream uses, discharges for the maintenance or perhaps even the enhancement of downstream fisheries resources will be available. The absence of discharge regime scenarios for the flow regulation scheme renders the foregoing assumption somewhat tenuous, therefore a potential for flow reductions detrimental to fisheries resources still exists.

It is suggested that the single most important mitigative opportunity associated with the Oldman River Dam development is the potential to provide more stable flow regimes for fisheries resources in the main stem of the Oldman River below both the Oldman River Dam and the L.N.I.D. weir. Various recommendations for flows for fisheries are summarized in Table 3. Generally an increase over normally low flows from October through April is desirable as well as assuring adequate flows below the L.N.I.D. weir. The weir frequently results in artificially low discharge in July, August and September. A reduction of peak flows normally occurring in May, June and July is largely beneficial, however provision for occasional flushing flows is desirable. The latter need not be an annual event and can be of fairly short duration; once every two or three years to flush accumulations of sediments would likely be adequate. Discharge regimes to reduce impacts on fish will be more difficult to achieve in

Table 3. Recommended in-stream flow needs for fisheries in the Oldman River in the Oldman River Dam Study area.

Source	Location	Purpose	Flows (cms)		
			Nov. to March	April to Oct.	June
Acres, 1978 UMA, 1978	below LNID weir	hardship	3.88	3.88	n/a
	below LNID weir	minimum desirable	7.76	15.55	n/a
	below LNID weir	desirable	15.55	23.31	n/a
Radford, 1975	below Oldman River Dam	minimum	13.34	26.65	88.89
Longmore and Stenton, 1981	Brocket	minimum	9.2	18.4	n/a

the reach of the Oldman River between the dam and the L.N.I.D weir. This reach must occasionally deliver flows of up to an additional 43 cms to the L.N.I.D. canal for irrigation purposes. The most feasible means of reducing the impact of the fluctuating discharges on fish in this reach is to assure that changes in discharge to supply the L.N.I.D. canal are gradual. McCart (1978) suggests that major changes should be spread over at least 72 hours. McCart further suggests that all flow criteria for fisheries be designated as instantaneous flows rather than monthly, weekly or daily means. It is of little benefit to fisheries if a weekly average flow includes one day of zero discharge.

The mitigative effects of flow augmentation for fisheries downstream of the Oldman River Dam could be further enhanced by utilizing in-stream habitat improvement devices. From the limited habitat information available for the channel below the L.N.I.D. weir it appears that increasing available cover, overwintering and/or rearing habitat, principally for mountain whitefish, would be of greatest benefit.

Mitigation of downstream temperature effects is possible by incorporating a multiple level withdrawal system in the dam design. A multiple level withdrawal system could also significantly reduce the threat of downstream fish kills which can occur during the first few years of dam operations with low level delivery tunnels.

The barrier to upstream migration created by the Oldman River Dam might be mitigated by providing fish passage facilities such as fishladders, lift systems or capture and transport systems. There has been no recommendation for provision of fish passage at the Oldman River Dam site, likely due to the high cost, technical difficulties and/or low probability of use of facilities to pass fish over a dam in excess of 70 m in height.

3.7 DATA GAPS AND FURTHER STUDIES

3.7.1 Fish Population Studies

Two areas for further studies of fish populations are suggested, both being relatively short term and seasonal in nature and intended to provide input to refine impact assessment and mitigation design.

Evaluations of brown and rainbow trout populations in the lower Crowsnest River (Lundbreck Falls to the river mouth) and of rainbow trout and mountain whitefish populations in sections of the Oldman and Castle Rivers above the reservoir FSL, with emphasis on spawning activity by adults and rearing use by juveniles, should in part reveal the potential for recruitment from these populations to the Oldman River Reservoir and aid in the design and/or implementation of mitigative measures. Field operations should be concentrated in late April - early May and October/November.

An evaluation of the use of the Oldman River below the L.N.I.D. weir by mountain whitefish for spawning, rearing and overwintering is recommended. Spawning evaluation study design could follow the methods that O'Neil et al. (1982) utilized effectively in their study of mountain whitefish spawning in the Oldman River above the L.N.I.D. weir. Sampling and observation at freeze-up and occasionally during the winter should provide adequate data on overwintering and rearing. Results would be utilized to further evaluate impacts and

define mitigative opportunities and methods.

3.7.2 Habitat

Perhaps the greatest need for further habitat studies is to determine in-stream flow needs for fisheries in the Oldman River downstream from the dam to at least Lethbridge. Whatever method is used to determine in-stream flow criteria, provision should be made in the study for specific evaluation of mountain whitefish spawning, rearing and overwintering habitat. The results of the in-stream flow need studies can be utilized to aid in the development of discharge regime scenarios for the Oldman River Dam. Discharge criteria in combination with the mountain whitefish habitat evaluations can be used to refine impact assessments and design additional mitigative measures.

Once drawdown regime scenarios for the reservoir have been developed, the probable quality of the reservoir habitat can be better evaluated and identification of appropriate mitigative enhancement opportunities can be made.

A habitat inventory of the lower Crowsnest River (below Lundbreck Falls) and sections of the Oldman and Castle Rivers above the reservoir, carried out in conjunction with fish population investigations, should be undertaken with emphasis on spawning habitat and cover for rainbow trout, brown trout and mountian whitefish. The results of this survey will

indicate the necessity for and feasibility of undertaking habitat enhancement as a mitigative measure.

3.7.3 Other Areas for Further Study

In a recent essay, Larkin (1984) noted that environmental impact assessment programs in Canada rarely include comprehensive, long term, after-the-event assessments. Given the probability for further flow regulation schemes utilizing dams in Alberta in the future (Alberta Environment, 1984), long term studies of the effects of impacts and mitigation of the Oldman River Dam may be appropriate at this time to provide concerned agencies with a well documented evaluation to provide future guidance. There have, for example, been no long term studies on the upstream effects of reservoirs in Alberta and while some mitigation has been undertaken for some reservoirs in Alberta, no follow-up studies to evaluate the efficacy of the measures have been carried out.

4.0 SUMMARY

Construction of the Oldman River Dam on the Oldman River near Pincher Creek, Alberta will result in flooding of portions of the main stems of the Oldman, Crowsnest and Castle Rivers and will alter flow regimes downstream of the dam in the Oldman River. In order to aid in the preparation of a plan to identify and design mitigative opportunities an overview of the fishery resources, habitat and sport fishing use of the area affected by the dam and the impacts and mitigation of the dam was undertaken.

The area of probable downstream impact extends beyond the City of Lethbridge and perhaps beyond to the mouth of the Oldman River, however the fisheries study area extended from Fort MacLeod on the Oldman River upstream on the main stem some 125 km and included about 26 km of the lower Castle River and 12 km of the lower Crowsnest River.

The fish species found in the Oldman River Dam study area consist both of coldwater and coolwater types. The rainbow trout and bull trout are limited in distribution downstream to about Brocket on the Oldman River and the brown trout are limited to the lower Crowsnest River. Mountain whitefish are more catholic, ranging throughout the study area and are the most abundant sport fish present. The mountain whitefish also complete their entire life cycle within the study area, whereas the other salmonid species either complete some phase

of their life cycle outside the study area (rainbow trout, bull trout) or are isolated within some part of the study area (brown trout). The upstream distribution limit of coolwater sport fish such as lake whitefish, northern pike, walleye and goldeye in the Oldman River is between Fort MacLeod and Brocket, varying somewhat with species. Several non-game species such as white, longnose and mountain suckers and burbot are facultative and are widely distributed in the Oldman, Castle and Crowsnest Rivers in the study area.

The Oldman River above Brocket and the lower Castle and Crowsnest Rivers are coldwater habitats, while the section from Brocket downstream is considered transitional between coldwater and coolwater habitat. A variety of life requisite habitat complexes are present in the study area. Spawning habitat for mountain whitefish is particularly abundant. Feeding areas for all species are well distributed, however rearing habitat, particularly for young-of-the-year fish, is not as abundant. Overwintering habitat is abundant in the Oldman River above Brocket and in the lower Castle River but is not common in the lower Crowsnest River and may be lacking in the Oldman River main stem below the L.N.I.D. weir. The three major streams in the study area are rated as class 1 for sport fish capability.

The sport fishery supported by the study area streams is generally of high quality. The coldwater sections are highly

rated and well utilized, having provincial and even international importance.

The Oldman River Dam will impact the fishery resources in the study area during the construction phase, will have effects both upstream and downstream, and will inundate riverine habitats. Construction can increase sedimentation and water pollution, block fish passage and reduce downstream flows to the potential detriment of fisheries resources. Inundation of high quality riverine habitats will displace the desireable salmonid species which will be replaced by coarse fish species. The reservoir will be considerably less productive than the riverine habitat and will offer generally poor habitat. The reservoir will also be poorly suited to angling. Impacts upstream of the reservoir will likely be limited to changes in fish species composition and abundance. Coarse fish may dominate upstream populations, particularly on a seasonal basis. Perhaps the single most significant impact of the Oldman River Dam will be its downstream effects, which can be either positive or negative. If the operation of the dam and/or the L.N.I.D. weir cause major reductions in flow, habitat and fish populations downstream will be severely degraded. Conversely, if the Oldman River Dam can deliver augmented flows, which can subsequently be passed by the weir, downstream fisheries resources will benefit. Improvement in the quality and extent of habitat for coldwater species and increases in productivity may also result if the dam uses a

low level withdrawal/delivery system. The dam will act as a barrier to upstream fish movement and fish may be stranded in an isolated section of channel between the spillway outlet and the delivery tunnel outlet.

A number of mitigative measures have been suggested to reduce or compensate for the impacts of the Oldman River Dam. The potential for realizing positive impacts through flow augmentation is perhaps the most significant mitigative opportunity. Opportunities also exist to enhance certain physical habitat components upstream and downstream of the reservoir and perhaps within the reservoir as mitigative measures. Short term compensatory mitigation for the loss of the existing salmonid fishery may be effected by stocking the newly inundated reservoir. Prevention of most construction impacts can be achieved by incorporating a series of operating conditions into a construction procedures plan to reduce the threat of sedimentation, pollution and dewatering.

The most immediate need for further study is to determine in-stream flow needs for fisheries downstream of the Oldman River Dam. These criteria along with information on other water use requirements can then be used to determine probable operating regimes for the dam. Once this information is available, mitigative opportunities can be more accurately evaluated and designed. In order to better determine the feasibility of undertaking instream habitat enhancement

measures it is advisable to evaluate existing fish populations and habitat in the areas designated for enhancement. The Oldman River Dam project may be suited to a long term study to determine the effects of impacts and mitigation.

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